

MTP Temperatures and Tropopause on the ER-2 and WB-57 During CRYSTAL-FACE

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***In-Situ* Aircraft Temperature Intercomparisons**

Microwave Temperature Profilers (MTPs) flew aboard both the ER-2 and WB-57 during CRYSTAL-FACE. The MTP flight level temperature is calibrated by careful comparison with radiosondes near the aircraft flight track. Although not required, we generally use other *in situ* temperature measurements to transfer the calibration. We therefore compared MMS temperatures on the ER-2, and MMS and PTW temperatures on the WB-57, to radiosondes to determine whether any corrections were needed. Preliminary MMS files were used on both aircraft as final data were not yet available; final PTW data was used on the WB-57.

ER-2 results based on 25 radiosonde comparisons:

$$T_{\text{raob}} = T_{\text{mms}} + (0.30 \pm 0.21) \text{ K}$$

However, the final MM files for two flights checked raised the temperature 0.36 ± 0.03 K, so there is excellent agreement with radiosondes for the final MMS data. These changes were examined using only data taken at cruise altitudes.

WB-57 results based on 27 radiosonde comparisons:

Using the preliminary MM files:

$$T_{raob} = T_{mms} - (0.51 \pm 0.22) \text{ K}$$

Two flights that were checked using the final MM files raised the temperature 0.06 ± 0.24 K, which would slightly increase the discrepancy with radiosondes. More important however is the much larger standard deviation on this changes. It thought that this is due to the post-mission attitude corrections to the static pressure. These are much more important on the WB-57 than ER-2 because of much more frequent attitude changes.

Using final PTW data and the “fast” temperatures, we found:

$$T_{raob} = T_{ptw} - (0.32 \pm 0.22) \text{ K}$$

The ER-2 MTP data was just reprocessed using the final MMS files to transfer the calibration since we believe they are in agreement with radiosondes.

The WB-57 MTP data was processed using the final PTW files --corrected by -0.32 K -- to transfer the calibration.

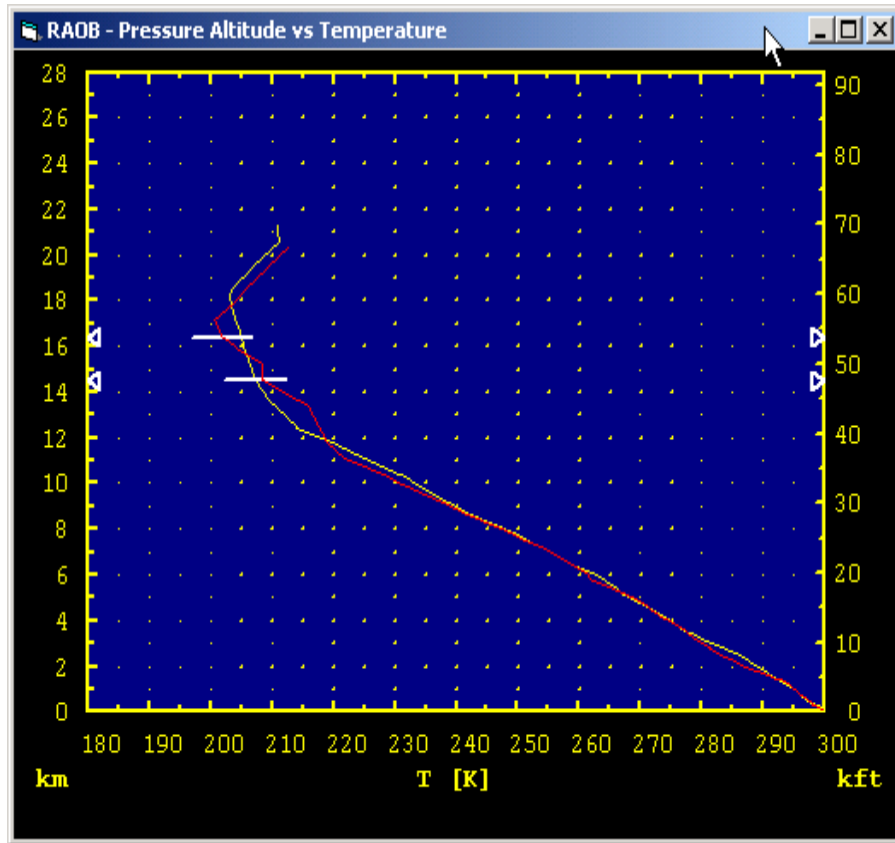
Sharp and Dull Tropopauses

When radiosondes collected during the CRYSTAL-FACE campaign were examined before calculating MTP retrieval coefficients, it was noted that the profiles did not always have a sharp inversion at the tropopause as is the case in the deep tropics. It was therefore decided to separate the radiosondes into two groups -- those with sharp tropopauses and those with dull tropopauses -- to better capture this distinction in the retrievals.

As can be seen in the examples on the following slide for radiosondes launched 6 and 12 hours apart, this can cause the actual tropopause height to change by as much as 2 km. Because these changes occur fairly quickly, they are almost certainly related to local convection, and it probably makes more sense to think of a *tropopause layer or region*. In the examples shown, it appears that the dull tropopause (yellow) occurs early in the day, and that the sharp tropopause (red) occurs later. We have not attempted to correlate this with the presence or absence of convection.

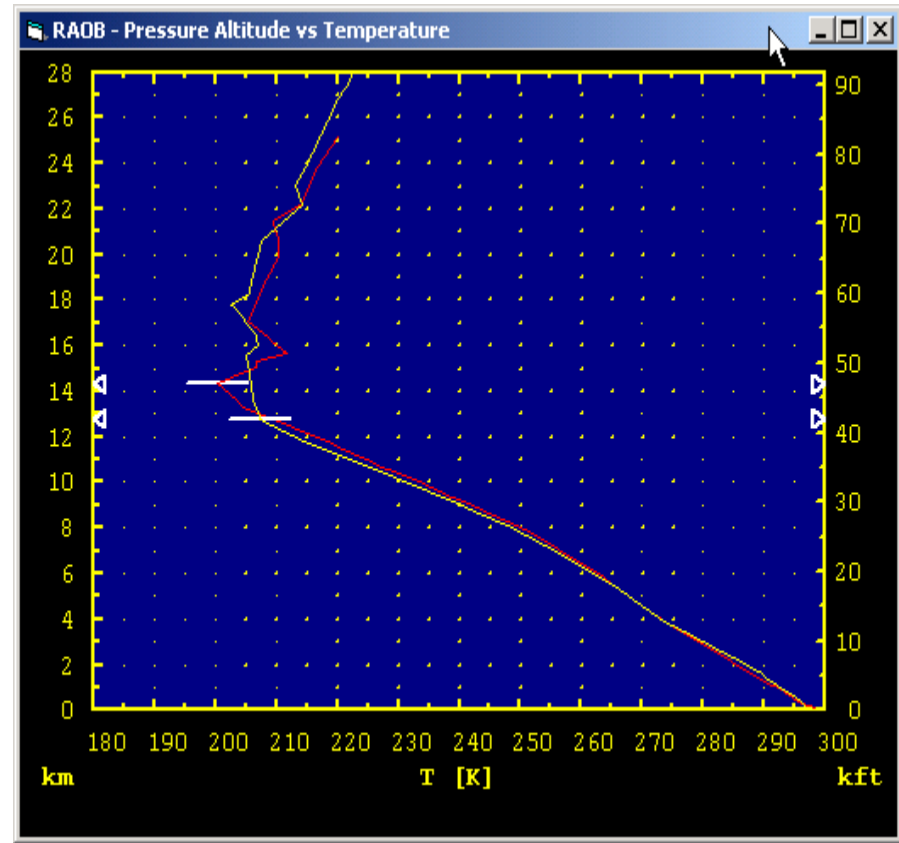
As a result, it should not be surprising that the MTP retrievals should have “noisier” tropopauses than if flying in the absence of heavy convection.

Sharp and Dull Tropopauses in Radiosondes



07.29.00UT(red) & 07.29.12UT(yellow)

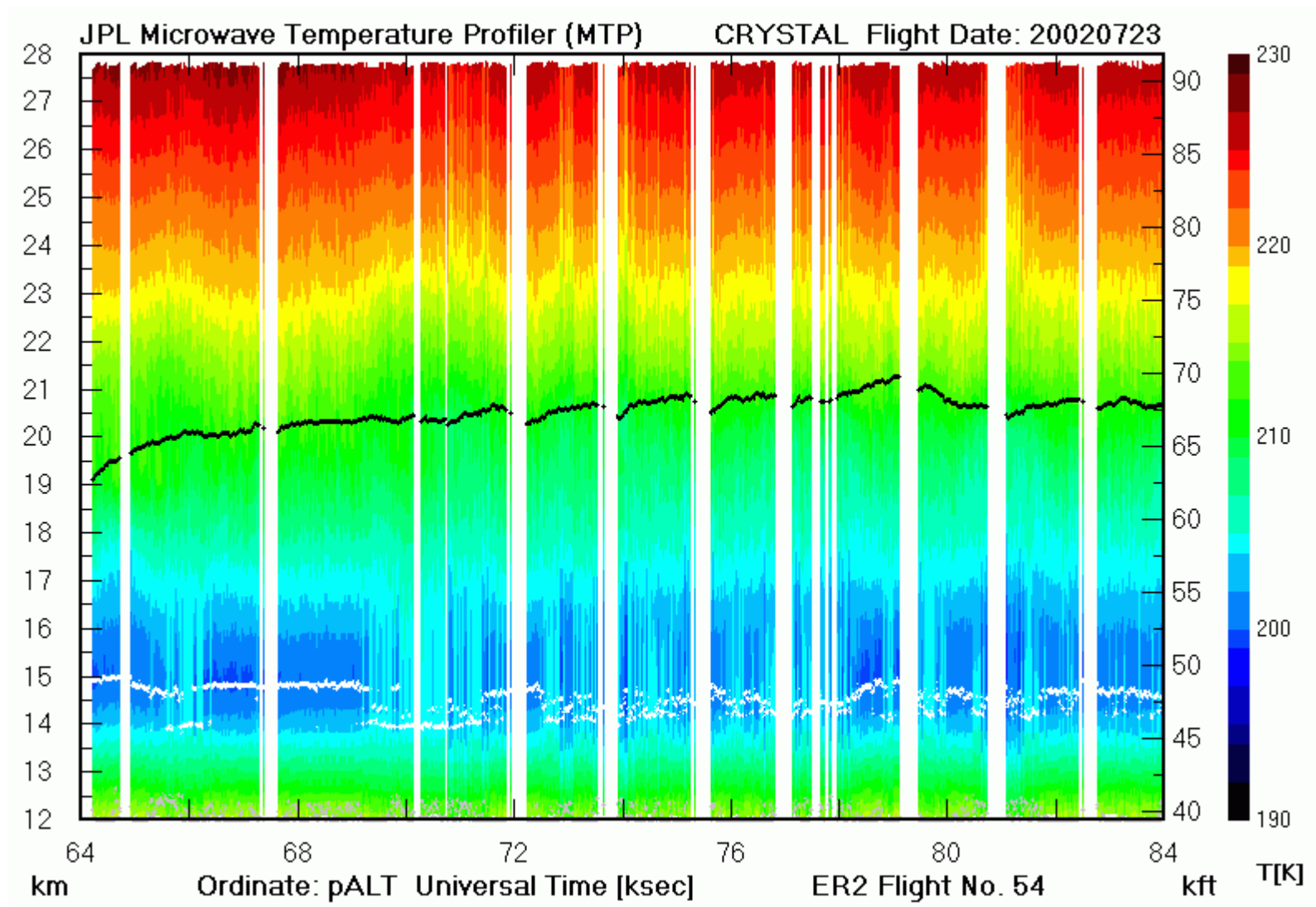
Example of two Key West radiosondes launched 12 hours apart. Tropopause height changes by nearly 2 km between the “dull” trop (yellow) and the “sharp” trop (red). The white line is the tropopause altitude.



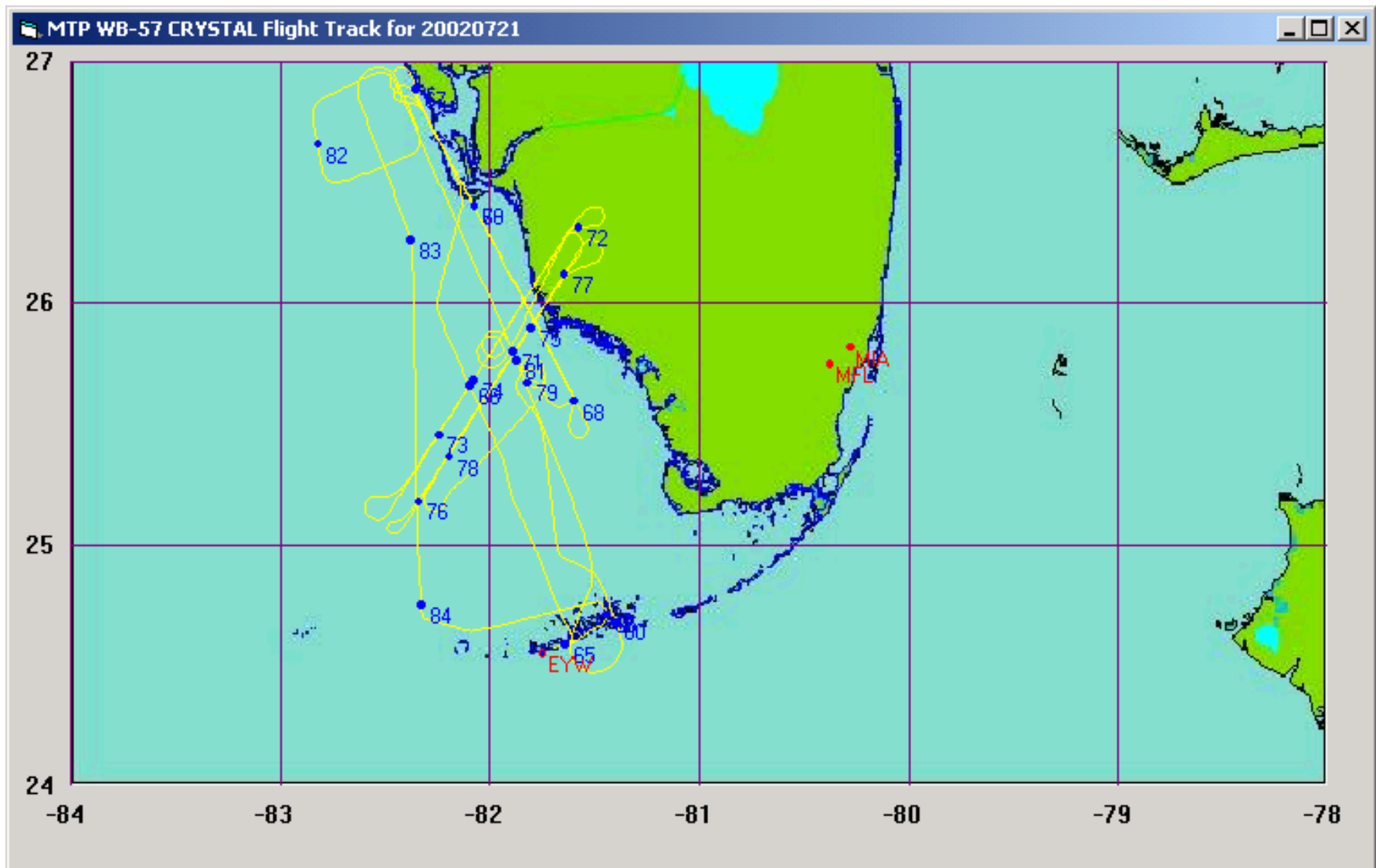
07.10.12UT(red) & 07.10.18UT(yellow)

Example of two Miami radiosondes launched 6 hours apart. One (yellow) is “dull” and the other (red) is “sharp.” The sharp sonde also shows significant structure above the trop. The white line is the tropopause altitude.

The Effect of Sharp and Dull Tropopauses on MTP Retrievals



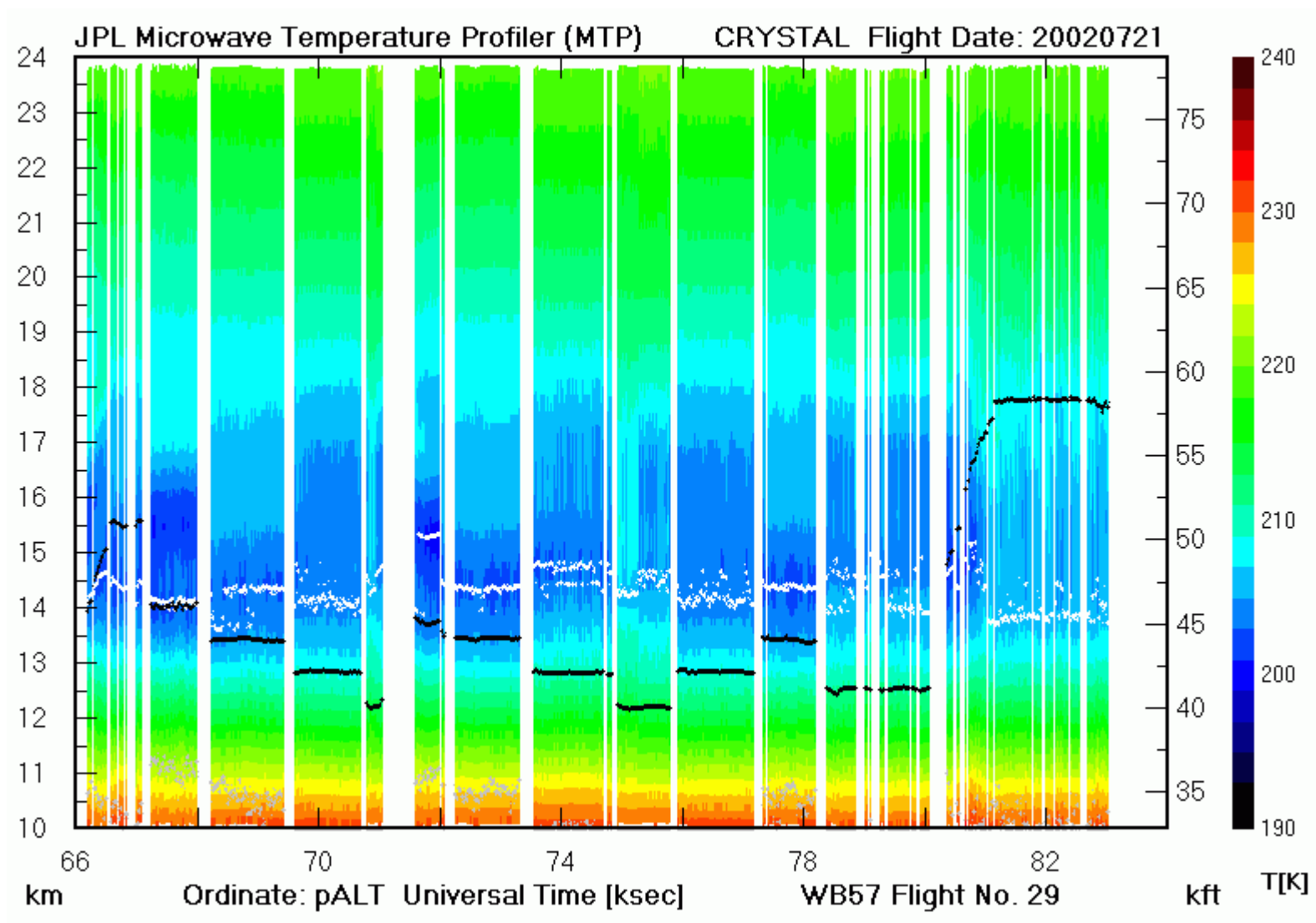
A color-coded temperature curtain (CTC) for the ER-2 flight of July 23, 2002.



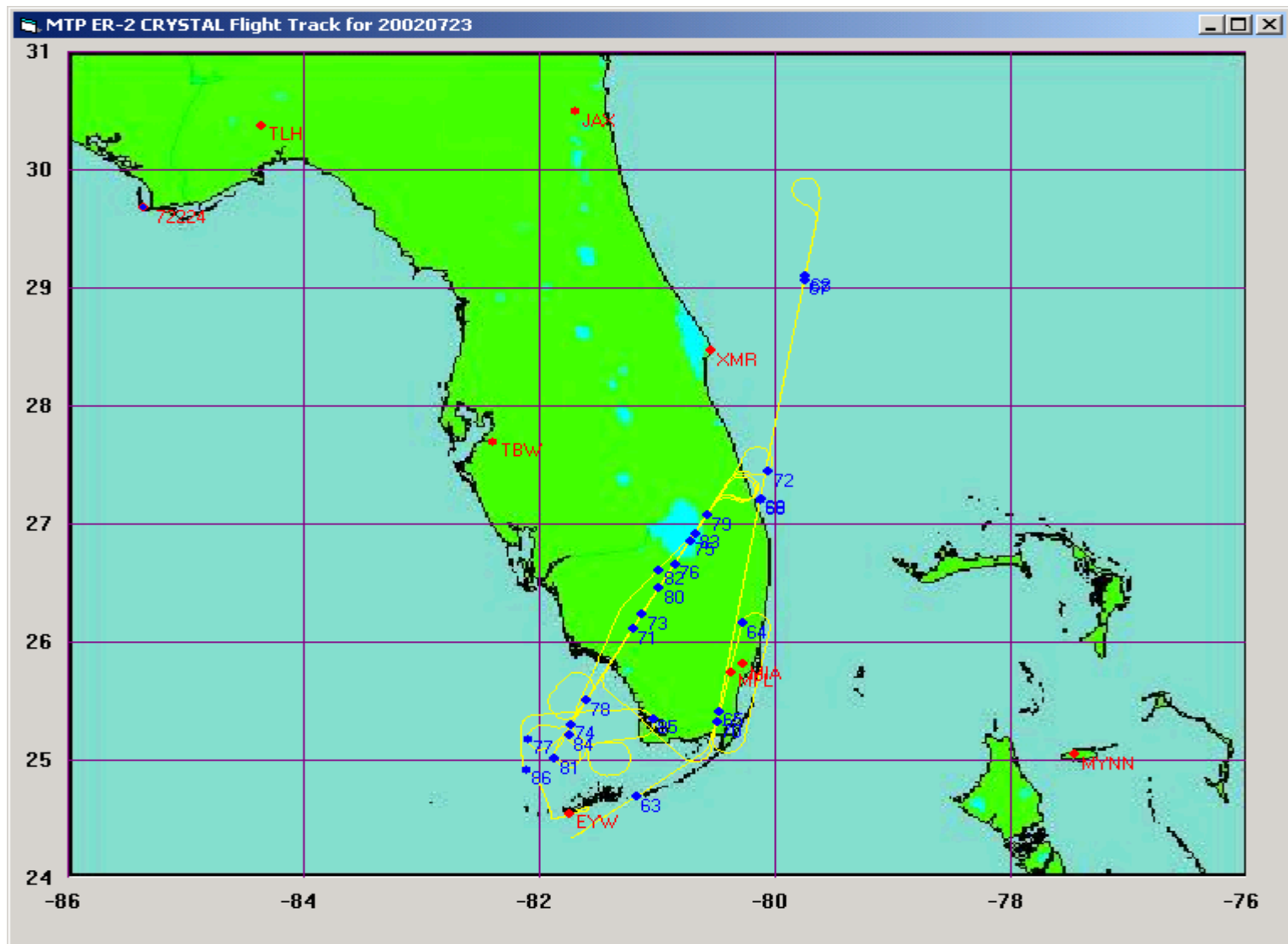
WB-57 Flight Track on 2002.07.21 (Blue dots are UT ks)

Early in this flight at 65 ks UT, retrieval coefficients based on a dull tropopause were found to best match the MTP measurements. As a result a lower tropopause was found and the tropopause temperature was warmer than, say, after 71 ks when retrieval coefficients based on sharp (and colder) tropopauses were found to better match the MTP measurements.

Two important points also need to be made: first, during most of this flight, the ER-2 was more than 6 km above the tropopause. At this distance, the MTP cannot produce an accurate tropopause measurement. The retrieved tropopause altitude will simply reflect the average tropopause altitude of the radiosondes used to calculate a particular set of retrieval coefficients. However, since the radiosondes used to calculate the retrieval coefficients (RCs) were from the deployment period, the tropopause solutions should be good. The second point is that we could have easily avoided this "jumping" tropopause situation by allowing retrievals with only the sharp or dull RCs. While this would produce a much better behaved tropopause solution, it would not be "fair" to measurements since, as shown above, both sharp and dull tropopauses can be present on short time periods (or similarly, over short distances, although this case can't be made using radiosonde measurements.)



A color-coded temperature curtain (CTC) for the WB-57 flight of July 21, 2002.



ER-2 Flight Track on 2002.07.23 (Blue dots are UT ks)

Shown above is the temperature curtain for the WB-57 flight of July 21, 2002. Since the WB-57 generally flew close to the tropopause during CRYSTAL-FACE, the situation is very different than for the ER-2. Because the WB-57 flew close to the tropopause, it should be able to make accurate tropopause height measurements, but whether sharp or dull RCs are used for the retrievals will depend sensitively on just how close the WB-57 was to the tropopause. The MTP will certainly be able to tell whether the tropopause -- sharp or dull -- is above or below the WB-57, but just where the measured tropopause lies will depend not just on the proximity of the WB-57, but also on the actual tropopause shape. As for the ER-2, a "better-behaved" tropopause solution could be found by using only sharp or dull RCs, but there is no justification for doing this. In fact, it is certainly reasonable to expect that very active thunderheads might change the ambient tropopause height and the temperature there. We prefer to let the measurements speak for themselves rather than make unjustified choices. As was the case for the ER-2, the metric that evaluates the quality of the temperature profile retrievals was excellent.

Additional Information Is Available

On Radiosonde Comparisons:

<http://reductionism.net.seanic.net/bgary.mtp/face/Face.htm>

On Other CRYSTAL-FACE Work:

<http://mtp.jpl.nasa.gov/missions/crystal/crystal.html>